Mitral valve annuloplasty with both rings showed good long-term clinical results. There were no statistical clinical differences between the Carpentier ring and the Duran ring, and follow-up echocardiography demonstrated that both early and late postoperative left ventricular dimensions were significantly reduced and that left ventricular function was significantly improved in both groups. More long-term data might be required to determine the superiority of either of the rings. Meticulous operative skills and intraoperative transesophageal echocardiographic evaluation are mandatory to prevent the late recurrence of MR.

References

1. Carpentier A, Deloche A, Dauptain J, Soyer R, Blondeau P, Piwnica A, et al. A new reconstructive operation for correction of mitral and tricuspid insufficiency. *J Thorac Cardiovasc Surg.* 1971;61:1-13.
2. Duran CMG, Pomar JL, Cucchiara G. A Flexible ring for atrioventricular heart valve reconstruction. *J Card Surg.* 1978;19:417-20.
3. Okada Y, Shomura T, Yamaura Y, Yoshikawa J. Comparison of the Carpentier and Duran prosthetic rings used in mitral reconstruction. *Ann Thorac Surg.* 1995;59:658-663.
4. Kwan J, Shiota T, Agler DA, Popovic ZB, Qin JX, Gillinov MA, et al. Geometric Differences of the mitral apparatus between ischemic and dilated cardiomyopathy with significant mitral regurgitation. *Circulation.* 2003;107:1135-40.
5. Spence PA, Peniston CM, David TE, Mihic N, Jabr AK, Narini P, et al. Toward a better understanding of the etiology of left ventricular dysfunction after mitral valve replacement: an experimental study with possible clinical implications. *Ann Thorac Surg.* 1986;41:363-71.
6. David TE, Komeda M, Pollick C, Burns RJ. Mitral valve annuloplasty: the effect of the type on left ventricular function. *Ann Thorac Surg.* 1989;47:524-8.
7. Castro LJ, Moon MR, Rayhill SC, Niczyporuk MA, Ingels NB, Daughters GT III, et al. Annuloplasty with flexible or rigid ring does not alter left ventricular systolic performance, energetics, or ventricular-arterial coupling in conscious, closed-chest dogs. *J Thorac Cardiovasc Surg.* 1993;105:643-59.
8. Van Rijk-Zwikker GL, Mast F, Schipperheyn JJ, Huysmans HA, Bruschke AVG. Comparison of rigid and flexible rings for annuloplasty of the porcine mitral valve. *Circulation*. 1990;82(5 suppl):IV58-64.
9. Carpentier A. Cardiac valve surgery—the "French correction." *J Thorac Cardiovasc Surg.* 1983;86:323-37.
10. Lillehei CW, Gott VL, Dewall RA, Varco RL. Surgical correction of pure mitral insufficiency by annuloplasty under direct vision. *Lancet.* 1957;77:446-9.
11. Reed GE, Pooley RW, Moggio RA. Durability of measured mitral annuloplasty: seventeen-year study. *J Thorac Cardiovasc Surg.* 1980; 79:321-5.
12. Kay JH, Egerton WS. The repair of mitral insufficiency associated with ruptured chordae tendineae. *Ann Surg.* 1963;157:351-60.
13. Carpentier A, Chauvaud S, Fabiani JN, Deloche A, Relland J, Lessana A, et al. Reconstructive surgery of mitral valve incompetence: ten-year appraisal. *J Thorac Cardiovasc Surg.* 1980;79:338-48.
14. Galloway AC, Grossi EA, Bizekis CS, Ribakove G, Ursomanno P, Delianides J, et al. Evolving techniques for mitral valve reconstruction. *Ann Surg.* 2002;236:288-94.
15. Grossi EA, Saunders PC, Woo YJ, Gangahar DM, Laschinger JC, Kress DC, et al. Intraoperative effects of the coapsys annuloplasty system in a randomized evaluation (RESTOR-MV) of functional ischemic mitral regurgitation. *Ann Thorac Surg.* 2005;80:1706-11.
16. Sebbah HN, Rosman H, Kono T, Alam M, Khaja F, Goldstein S. On the mechanism of functional mitral regurgitation. *Am J Cardiol.* 1993; 72:1074-6.
17. Bolling SF, Deeb GM, Brunsting LA, Bach DS. Early outcome of mitral valve reconstruction in patients with end-stage cardiomyopathy. *J Thorac Cardiovasc Surg.* 1995;109:676-83.
18. David TE, Armstrong S, Sun Z, Daniel L. Late results of mitral valve repair for mitral regurgitation due to degenerative disease. *Ann Thorac Surg.* 1993;56:7-14.
19. Deloche A, Jebara VA, Relland JYM, Chauvaud S, Fabiani JN, Perier P, et al. Valve repair with Carpentier techniques: the second decade. *J Thorac Cardiovasc Surg.* 1990;99:990-1002.
20. Duran CM, Gometza BH, Saad E. Valve repair in rheumatic mitral disease: an unsolved problem. *J Cardiol Surg.* 1994;9:282-5.
21. Yau TM, El-Ghoneimi YAF, Armstrong S, Ivanov J, David TE. Mitral valve repair and replacement for rheumatic disease. *J Thorac Cardiovasc Surg.* 2000;119:53-61.
22. Flameng W, Herijgers P, Bogaerts K. Recurrence of mitral valve regurgitation after mitral valve repair in degenerative valve disease. *Circulation.* 2003;107:160913.

Discussion

Dr Aubrey C. Galloway, Jr *(New York, NY)*. This was a very nice presentation, and I congratulate you on doing a randomized trial, which we have too often been unable to do in this country. I do have some comments and questions.

The first comment is that this study includes a mixed group of patients, which limits your ability to draw conclusions. Although 66% of the patients had degenerative disease, 10% were rheumatic, and 10% had ischemic or dilated cardiomyopathy. The latter group really has a different mechanism for insufficiency than the degenerative patients, and they consequently have a different mechanism for late repair failure. These 2 groups really need to be evaluated separately.

For example, the patients with ischemic or dilated cardiomyopathy and functional MR had roughly a 25% failure rate for reoperation at 5 to 8 years. Did you see a difference in the rigid versus flexible rings in that group? Others have found that patients with ischemic or dilated cardiomyopathy have better results when rigid or semirigid devices are used.

Second, even when you looked at the overall freedom from reoperation and included all of the patients, there was roughly a 10% difference favoring the rigid group. Likewise, when you looked at freedom from recurrent 3 or 4+ MR, there was a difference favoring the rigid ring group, yet these differences were not statistically significant. Unfortunately, the study is underpowered to detect small or even moderate differences.

The third comment and question has to do with the way you analyzed the degenerative patients. We suspect that degenerative patients would be less likely to have a difference in durability based on the type of annuloplasty because late repair failure in these patients is more often thought to be due to surgical technique or leaflet pathology, such as repair of anterior versus posterior leaflet pathology or rheumatic versus degenerative status. I did not see repair of anterior leaflet pathology mentioned. Did you look at both repair techniques and pathology in your analysis?

Finally, because you used early postoperative residual MR as a variable for your late failure analysis, I think this might have skewed your results because the variable of early postoperative insufficiency might have overwhelmed any other factors that might have been significant. Obviously, patients who had significant early residual MR would be more likely to fail late. Did you analyze the degenerative group in terms of looking at only the preoperative or intraoperative variables, such as technique or pa-

thology, as predictors of failure? It might have been more helpful not to include early postoperative MR in the analysis.

Again, congratulations on a nice trial and the overall good results achieved.

Dr Chang. Thank you very much for your excellent questions and comments. For the first question, we suspected that there were some differences between the rigid ring and the flexible ring in the cohort with dilated cardiomyopathy compared with in the cohorts of idiopathic or ischemic origin. However, as you commented, there were only 40 patients with cardiomyopathy. We had analyzed the differences in the cardiomyopathy group with other groups, and we could not find any significant differences. However, the rigid ring favored the long-term results in recurrence of significant MR. We need more studies with more patients.

For the second question, we found that there were no differences in the long-term results between the anterior mitral leaflet problems and the posterior mitral leaflet problems. Since the late 1990s, we have used Gore-Tex sutures for new chordae formation. We could not find any differences between the anterior and posterior mitral leaflet pathology in terms of long-term results.

Dr Alain F. Carpentier *(Paris, France)*. I rise to congratulate you on this sort of study, which is very necessary, a randomized study, very well done, and I think it is the first, as far as I know, concerning the comparison between a flexible and rigid ring. Now there is no surprise that both rings provided a pretty good result because they are based on the same concept of circular annuloplasty as opposed to posterior support. However, based on new data, it is remarkable that we see a trend in favor of rigid remodeling annuloplasty, and this difference might increase with time, as shown by your curves, and might be also improved by using a Physio ring, which is more or less a ring that had 2 advantages of certainly flexibility but a remodeling concept. Therefore my only question, after having congratulated you, is whether you have used or whether you plan to use a Physio ring to see whether there is a difference with these 2 well-known rings.

Again, congratulations, and thank you very much.

Dr Chang. Thank you very much, Professor Carpentier. It was a great comment for me. We actually wanted to use the Physio ring at the time of it being commercially available. However, we suspected that there were minor problems of recurrence of MR with some elongation of the annulus. Although we attempted to coapt the anterior leaflet to the posterior leaflet, we might suspect that the annulus dilates a little bit more than expected during diastole, and we suspected there might be some recurrence of MR. Thus we have used the classical rigid Carpentier rings. I think the rigid ring might have better results in cases of dilated cardiomyopathy, idiopathic as well as ischemic. Thank you very much, sir.

Dr Carlos Duran *(Missoula, Mont)*. I rise to comment on this article, primarily because I knew that there were going to be a lot of people, and if they saw my face, they would expect I would have to say something. Basically, what I think is that there is not that much difference. And there is a tendency, a lot of it made by industry, of getting a new type of ring or band every few months. I do not know how many there are now available worldwide; there must be right around 30 to 40 types of rings. I think we are fussing too much about the ring and forgetting that the ring is the final thing of repair, and if your repair is bad, do not expect that the ring, whatever type of ring, is going to compensate for your incompetence or my incompetence. Therefore every time that someone comes along with a new ring, I say, that is fine, go ahead. The scientific basis behind this in 90% of the cases is completely absent. There is no reason except a picture or a fashion; you suddenly discover the mitral valve has the shape of a saddle, so you make a saddle shape. If tomorrow there is another great advance in the knowledge of the mitral valve, and it turns out that in a particular pathology one area is much higher than another, just change the ring. But do not forget that the ring does not solve a bad repair.

I congratulate the authors. This type of work is absolutely essential, and I hope you continue doing it and add other types of rings into the study. Thank you very much.

Dr Chang. Thank you, sir.